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ABSTRACT

This manual provides a set of tasks for use in the microteaching context of a Teaching Laboratory to be used in teaching pupils an approach to problem solving. The introduction describes the contents and functioning of the Teaching Laboratory and the way in which the manual should be used. Details of five lessons are then given. The first lesson is unstructured, the only requirement being that it should be relevant to the curriculum. It is followed by a description of the evaluation methods, the different aspects of the learning situation, and those of teaching problem solving. Lesson 2 presents the problem; lesson 3 formulates hypotheses; lesson 4 verifies hypotheses; and lesson 5 applies the generalization. In the description of each lesson the instructional objectives and methods are detailed, and an evaluation guide and listening guide are also included for each. (MBM)

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TEACHING FOR PROBLEM-SOLVING: A TEACHING LABORATORY MANUAL

(Preliminary edition)

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Thomas B. Gregory

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Foreword

Microteaching is one of the brightest innovations spawned in teacher education. Its attractiveness may be attributed to a number of interests and concerns. Some see microteaching, as it was developed at Stanford, as a substitute for a more regular, extended practice of teaching prior to a fifth-year internship. Others believe it an appropriate substitute for student teaching. Some view it as useful in the early induction of candidates into teaching. Still others look to it as a viable component in different elements of the teacher education program. However seen, microteaching seems to require only a few critical elements.

An indispensable element of microteaching, would seem to be the skill or task or set of skills or tasks upon which the teacher candidate focuses in this teaching exercise. The Stanford model includes a number of technical skills of teaching, e.g., establishing set, reinforcement, varying the stimulus. Quite likely, this list of skills is widely adopted and used in many programs. Major reasons seem obvious. This set of skills was the first developed. Too, attention to these skills appears productive in changing teacher candidates' behaviors. The attractiveness of microteaching

and the availability of the early set of skills should not inhibit, on the other hand, development of alternative conceptions and programs. Indeed, development of many sets of skills or tasks useful in the microteaching setting should be fostered.

This manual, Teaching for Problem-Solving, is one set of tasks developed for use in the microteaching context. These tasks direct candidates' attention to a rather specific system of teaching. In keeping with other work in the Texas Research and Development Center, this set is concerned with pedagogic tasks with which teachers must engage if they are to teach pupils an approach to problem-solving. This manual has been used in a major research project conducted by its author. Research results indicate that beginning teacher candidates working with these tasks in the Teaching Laboratory do change their teaching behaviors. The author nevertheless believes the tasks may be even more useful to candidates after they have attended to some more general and possibly basic tasks, e.g., clarifying objectives, questioning, explaining. For example, the tasks might be very useful in special methods courses in social studies, mathematics, and science. They might have less applicability in special methods courses in art, music, business, and physical education. That usefulness may

vary as a function of the teaching field is now only a hypothesis worthy of examination. The manual, in this experimental version, is issued that teacher educators may use it, may react to it, and may experiment with it.

Dr. Thomas B. Gregory, the author of this manual, is now Assistant Professor of Secondary Education, School of Education, Indiana University. An experienced teacher in Ohio schools, he was one of several key individuals who participated in the early development of the Teaching Laboratory at The University of Texas at Austin and who contributed to the manual used experimentally in that Laboratory. This experience served him well in preparing this new manual.

The author would appreciate hearing from those who examine and/or use the manual. This type of feedback is important to planned revision and experimentation. Permission to reproduce the manual should be requested from the Research and Development Center for Teacher Education, The University of Texas at Austin.

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TEACHING FOR PROBLEM-SOLVING:
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Rationale for the Teaching Laboratory. Most teacher education programs are comprised of three basic phases: 1) courses in Educational Psychology, in Curriculum and Methods, and in the History and Philosophies of Education; 2) observations in the schools; and 3) student teaching. The rationale for such a program is fairly obvious. Courses attempt to give the student the prerequisite knowledge necessary for teaching; observations allow him to relate this knowledge to real situations; and student teaching permits him to gain experience at applying his newly acquired professional knowledges and skills. The paradigm has been widely accepted if not embraced.

Such a traditional program is not enough. At least one additional phase is desirable, one consisting of a series of laboratory components. These components collectively will be referred to as the Teaching Laboratory, the purpose of which is to bring at least a modicum of reality and specificity to the pre-student teaching phases of the teacher education program (Broudy, 1964; Davis and Gregory, 1968). Think of a continuum such as that in Figure 1.

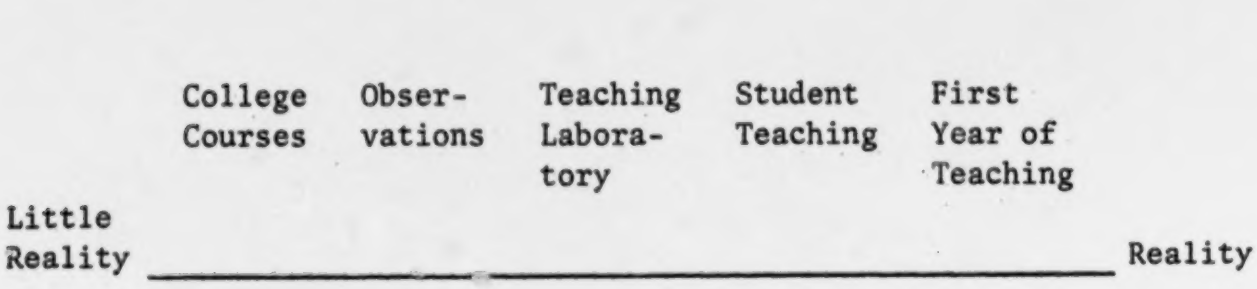

Figure 1

The Teaching Laboratory is viewed as a vechicle for encouraging the early relation and application of knowledges. Also, it is seen as an intermediate agent enhancing the probabilities of transfer fo knowledge and skills learned in the college classroom to the public school classroom by reducing their perceived dissimilarities.

Basic Description of the Teaching Laboratory. The Teaching Laboratory (TL) is a small room equipped with the basic classroom

furnishings, including desks, a blackboard, an overhead projector, and easy access to other standard audio-visual equipment. It also contains audio or video recording equipment with which to record the TL lessons taught by candidates. These records provide accurate and realistic feedback to teacher candidates using the Laboratory.

In addition, the Teacher Laboratory also contains from four to eight "students." They may be real students recruited from the public schools or other teacher candidates role-playing students of a given age and ability level. The latter has proven to be an expedient if not desirable alternative, at least in the case of secondary teacher candidates.

The Teacher Candidate's Role in the Teaching Laboratory. In the Teaching Laboratory, one is required, among other tasks, to incorporate specific teaching strategies into short TL lessons or "teaches." TL lessons will range from five to twenty minutes in length. When not teaching, a subject may be acting as an observer or student for another candidates' teach. In all cases candidates are observers and evaluators, writing comments on teaches made by their colleagues and possibly by themselves.

Since role-playing students may be an additional responsibility, the use of some simple procedures may make the assumption of a specific

role easier. An example may be useful in making this point:

> Situation Requirement: Be an average tenth grader in English. For a start, think back to your own tenth grade English class. Think of your teacher, your classmates, and your collective attitudes toward your teacher, each other, English, and school in general. Did the class easily volunteer information or was it reticent? Was your class really average, or did most of the students in it go on to college? It is possible for you to role-play yourself, or another student, or a composite of other students. Assume the role that seems most natural and exemplary to you. Your task may be complicated by the fact that you have never had the subject being taught. In such a case, you may consider yourself a student with learning problems. Use whatever other devices you find helpful. Do attempt to avoid stereotyped behavior, since it may encourage stereotyped reactions from your "teacher."

The Manual. This manual is designed to introduce teacher candidates to some of the important teaching strategies identified by educational and psychological research. Teaching is, in part, a psychomotor task in much the same sense that driging, acting, typing, and playing a musical instrument are. Obviously, learning any of these involves acquiring the necessary cognitive skills. But in addition, none of these tasks can be adequately learned without mastering their physical requirements.

This is generally best accomplished through actual practice on the task or on a closely related physical activity. This manual's

prime purpose is to guide teacher candidates to acquire widely accepted teaching behaviors through practicing them in a situation related to that found in a real classroom.

The rest of this manual will speak to the reader as a teacher candidate.

LESSON ONE

AN UNSTRUCTURED TEACH

The requirements for this first teach are quite simple. You are to teach a short lesson eight to ten minutes in length on some curriculum-relevant topic in the TL.

Just as jumping into the water is a prerequisite to learning how to swim, getting some first hand experience in the Teaching Laboartory is a prerequisite to learning and effectively applying specific strategies to later teaches. It is not atypical for you to be anxious or nervous on this first teach. On the contrary, you should be concerned if you are not; small amounts of anxiety are quite helpful in motivating one to perform tasks more effectively. There are at least three characteristics of this first teach that may contribute to your nervousness. The specific purpose of this teach is to help you overcome them.

First, it is not unusual for beginning teacher candidates to be concerned about many matters of great personal importance to them. Some examples are what to do with one's hands, how to move about the room in a casual manner, how to anticipate the students' reaction to one's lesson, and how to avoid one's undersirable speech mannerisms. Such problems disappear with experience, but can be disconcerting to a beginner. Recognition of this should facilitate

the reduction of any anxiety associated with these matters.

Second, teaching in general and especially TL teaching can be termed an ego-involvement situation (Sherif and Cantril, 1947). You come to teaching with a well-established conception of yourself and your own personal competencies. For instance, you would not be here if you did not think you could be a good teacher. In the Teaching Laboratory, you are confronted with the necessity to "prove" to yourself that your assessment of your own competence is correct; you are, in other words, ego-involved. This first teach gives you an opportunity to begin receiving meaningful feedback to use in assessing how realistic your self-concept is in regard to your ability as a teacher.

Third, any time one performs (in a behavioral rather than a theatrical sense), he is unconsciously aware that he is being evaluated. For example, think of the number of unsolicited clarifying statements (e.g., giving examples, paraphrasing, asking for agreement, interjecting qualifying statements) made in everyday conversation to insure that others will accurately understand one's position on matters. This unconscious awareness surfaces to a conscious awareness in the Teaching Laboratory since one's performance is being formally evaluated. It is compounded by the additional awareness that part

of that evaluation is being made by one's peers. Since all place high value on their peer status, any threat to it is anxiety producing. As you teach in the Laboratory you probably will find your colleagues quite supportive and the threat to status and the anxiety accompanying it greatly reduced. Since this teach is not formally evaluated, it gives you an opportunity to begin coping with whatever anxieties you may have. You also have the opportunity to make some important first steps in terms of a self-evaluation of your teaching behavior.

Some teacher candidates come to this course with the feeling that they "just have to teach," that no other recourse is open to them, that not to teach would be a great personal failure. The anxiety produced by the thought of failure results in a very high level of motivation--in some cases, too high. That is, for some, anxiety is so great that it impairs performance and must be reduced to facilitate acceptable performance in the Teaching Laboratory. If you find yourself in this position, consultation with your instructor may produce the means for alleviating your individual concerns.

To repeat, your task for this first teach is to prepare and teach a ten-minute lesson in your subject area. Your only requirement is that it be curriculum relevant. That is, choose a topic that would legitimately be taught in a public school classroom. At first,

you may feel that ten minutes is not enough time to adequately teach anything. This is not the case. Most long lessons are really made up of many short segments connected by transitions. Roughly plan in outline form a 50-minute lesson by setting down the procedure you might follow. Examine each of the major outline headings and you will find that most can be treated in ten minutes or less. In fact, if your outline has five or more headings, some must be. Select anyone of these as the topic of your first teach. It can be the beginning, middle, or end of the larger lesson. By analogy, you are being asked to think of a theme topic, but are required only to prepare one paragraph of the total paper.

In this lesson, you may encounter a "clean slate" problem--the largely falacious idea that you must always teach everyone and everything "from the beginning." An examination of several textbooks in just one area of one of your teaching fields will produce vast differences in the ordering of topics. Such an exercise reveals that each field has many possible starting points for instruction. Nevertheless, some topics do require cetain prerequisite knowledge. If your TL lesson topic requires such prerequisite knowledge, the necessary information can be "taught" by giving your students a prepared handout containing the necessary information. Admittedly,

some topics are inappropriate to the Teaching Laboratory, but they are far fewer than one might imagine.

The time limit on this first TL lesson is not crucial. It can be as short as five minutes if you like. You may find it helpful to receive a signal after eight or nine minutes so that you can smoothly bring your teach to a close. Assume that at ten minutes the bell has rung, and your students will have to leave for their next class and you must conclude your lesson as quickly as possible.

So that you will better understand the criteria used in evaluating each teach, they are stated in behavioral terms. Since this first teach has very little structure and is not formally evaluated, it does not require the several instructional objectives necessary for subsequent, more structured teaches.

INSTRUCTIONAL OBJECTIVES FOR FIRST TEACH

1. The student will be able to teach a ten minute lesson on some curriculum-relevant topic in the Teaching Laboratory.

EVALUATION

One of a teacher's most difficult and important tasks is making fair, accurate evaluations of his students' performances. Anytime one is asked to describe everything he knows about another human being by one letter or a numeral, he tries, in effect, to dichotomize human experience. The task is both impossible and misleading. Yet, teachers continuously are required to do both. In the Teaching Laboratory, you will gain a great deal of direct experience in evaluating your colleagues' teaches. Hopefully this guided experience will improve indirectly your ability to evaluate the performances of your future students.

In general, the criteria upon which judgments will be made should be clear. This principle, easily understood, is less easy to implement. The best method presently available for dealing with this problem is by stating the criteria for acceptable performance in terms of observable behavior (See Mager, 1962). Such instructional objectives attempt to communicate concisely and accurately by avoiding the use of terms having many different interpretations (e.g., to know, to understand, to appreciate, tec.).

A well-written instructional objective satisfies four requirements necessary for the unambiguous communication of the criteria used in evaluation. Of those listed, the last three are taken from Mager (1962, p. 12).

1. The objective identifies who must perform the act. In the case of the tasks in this manual, the who is you, the teacher candidate.
2. The objective identifies the terminal behavior that is considered evidence that the desired learning has taken place and the objective has been accomplished. With respect to the tasks in this manual, the terminal behaviors are those of individuals who teach and are usually stated in terms of teaching behavior.
3. The objective attempts to define the desired behavior further by describing the important conditions under which the behavior will be expected to occur. The conditions under which you will perform the tasks in this manual are those present in the Teaching Laboratory (e.g., small number of students or colleagues, time limit, etc.). They are reasonably constant and, thus, are not repeated for each objective in every task.
4. The objective specifies the criteria of acceptable performance by describing how well the learner must perform to be considered acceptable. This requirement is difficult if not undesirable to fulfill with respect to the tasks of this manual. Teaching strategies are best considered as being inappropriate or appropriate to specific situations rather than being "good" or "bad." Consequently, the instructional objectives stated in this

manual have rather imprecise criteria for <u>acceptable</u> performance in general but more stringent criteria for appropriate performance in the specific situations created by each individual's teach.

Grades you assign to your colleagues should be based on how well they <u>appropriately</u> have fulfilled the instructional objectives specified for that teach. While teacher candidates are encouraged to select topics that will allow them to apply all the required strategies of a specific task, finding one is sometimes difficult. You should consider this in evaluating the appropriateness with which a specific teaching strategy has been used. The instructional objectives for a task attempt to operationally define appropriateness for each of the task's teaching strategies. This should enhance the agreement of individual evaluators.

Since grades are extremely limited in their ability to describe human behavior and in no way suggest ways of improving it, you and your colleagues will find more detailed feedback of great value in your attempts to improve your teaching. Thus, you will find it useful to supplement your grades to each of your colleagues with written comments conveying your reactions to their teaches.

Common sense is a good guide to what to write and how to present it. First, comments can refer to the specific criteria upon

which grades for a teach are based, or they can refer to the many other behaviors not being evaluated but still of crucial importance to effective teaching. Both are of value when they point the way to improved teaching behavior.

Second, everyone likes to hear about their strengths, but they also are interested in knowing their weaknesses. More precisely, they are interested in knowing <u>how</u> to overcome them. Therefore, <u>coupling</u> identifications of weaknesses with constructive suggestions for improvement is a highly desirable practice both in the Teaching Laboratory and later in teaching. Strive for a healthy balance in your criticism (i.e., identify about as many strength as weaknesses) and your suggestions will not only be accepted by colleagues but sought as well.

Third, avoid resorting to negative affect (e.g., "you did a bad job of . . ." or "that wasn't really teaching . . ."), or sarcasm (e.g., really now, did you mean to do that). One seldom slips into this mode of communication, but even small amounts of it can be very damaging to interpersonal relationships.

Fourth, work for <u>quantity</u> as well as <u>quality</u> in writing comments. Deciding which points will be most relevant to a colleague is often difficult. Writing many comments enhances the possibility

that you will hit upon a point of particular relevance to his present stage of development as a teacher.

Writing comments can be a nuisance, but it also can aid in development of the abilities to discriminate important aspects of the whole, to diagnose weaknesses, and to prescribe alternatives, all of which are important attributes of effective teaching.

In summary, teachers need to be good evaluators. The Teaching Laboartory offers you extensive experience in evaluating the performance of both your colleagues and yourself. Written comments are valuable when they are both constructive, and substantive. Comments are of most educational worth when they suggest directions in which to change behavior and the means through which to do it.

THE LEARNING SITUATION

Hopefully, the product of all teaching is learning. Regrettably, a teacher sometimes finds himself working in situations where little learning seems to be occurring despite his teaching efforts. The first question he may ask is "Why?" to which a multitude of "experts," lay and professional, will proffer a diversity of answers. Some will seem to conflict. Others may be reconciled with varying degrees of difficulty. A few may even constructively suggest solutions. All will probably be partially correct since learning is a complex problem.

Teacher candidates are sometimes confronted with what appear to be "cookbook" solutions to problems found in general learning situations. These "recipes" are the product of years of teaching experience and are not without value, but they seldom explain "why." In addition, the complexity of the learning process makes generalizations difficult, causing such solutions usually to be amended with numerous qualifying statements describing the circumstances under which a procedure is appropriate. Unfortunately, such descriptors can induce confusion as well as enhance clarity.

Teachers thus find themselves in the position of having to be able to select the most relevant suggestions of those available, synthesize these into an accurate explanation of the problem,

and develop means for remedying the situation. The undertaking is a formidable task. The classroom teacher, already burdened with numerous other responsibilities, is often the only person with sufficient knowledge of the specific situation to accomplish the task. The following learning model is proposed as a construct to both aid the development of explanations of why learning problems occur and suggest strategies for their remediation.

On the basis of existing research, three distinct, though closely related, variables emerge which must all be adequately satisfied if learning is to take place. They involve 1) the developmental status the individual brings to the learning situation, 2) the degree of incongruity experienced by the individual in the learning situation, and 3) the individual's conception of his own competence to deal with the learning situation with which he is confronted. An examination of learning situations where one of the variables is not satisfied may aid an understanding of the three variables and why each is essential to a productive learning situation.

The first variable involves the developmental status and prior learning of the individual. It is important that the learning situation fit the structure of his cognitive maps (ways of thinking), or what Piaget (1968) calls "schemata." For example, a teacher can

place a tall, narrow glass and a short, wide glass of equal volume in front of a six-year-old child. The teacher first fills the short glass to the brim with water and then pours it from there into the tall glass, filling it to the brim. To the question, "Which glass holds more water?" the child, focusing on the heighth variable, will answer "The tall one." Some children, focusing on the width variable, will answer "The wide one." Further pouring and questioning does not change the answer; the child is unable to see the fallacy in his answer because he has no concept of the conservation of matter, or more specifically, the conservation of volume. Because of his prior learning, he does not sense the incongruity raised by his answer and will not until he has "restructured his cognitive maps" or "transformed his schemata" or "learned."

The second variable is closely related to the concept of incongruity mentioned in the first. Learning requires the arousal of curiosity which is stimulated by an encounter with incongruity. A teacher might ask a group of seventh graders "Why is it that an airplane weighing many times the weight of a car can fly, but the car can't?" "Because the airplane has wings." If he allows this answer to stand, no curiosity is aroused, but if he probes "How do wings make an airplane fly?" and follows with related questions, he is well

on his way to fulfilling the requirements of the second variable, the encounter with incongruity.

The third and final variable, like the first, is internal, but it is primarily affective rather than cognitive in nature. It centers around what is usually termed self-confidence, or what White (1952, 1959) has termed "effectance" or "competence motivation." Consider an otherwise able student who is having trouble with algebra. He may continually be confronted with situations where the first two variables are satisfied, but the third is lacking. He has come to consider himself a weak algebra student and the problems he encounters seem overwhelming for his capabilities.

His dilemma becomes a self-fulfilling prophecy (Rosenthal, 1968) unless his teacher is able to diagnose the actual problem and guide him slowly through the process of solving the equation, encouraging him along the way and showing him "that it really isn't as hard as he thinks it is." High school dropouts are immediately defeated when presented with a two or three hundred page textbook, but see the same material as realistically within their grasp when it is given to them in ten or 15-page sections.

In summary, learning is a function of at least three variables: 1) the prior learning of the individual; 2) the degree to which the individual is aware of an incongruity; and 3) the individual's conception of his competence to deal with the situation. Learning problems occur when any one of the variables is inadequately satisfied. There

are many reasons why satisfaction of all three is difficult, but one of extreme importance is the uniqueness of the learning act for each individual. Trying to deal with learning (a largely individual process) by teaching a class (a group process) is extremely difficult.

You may find the three-variable concept of the learning model a useful construct in planning your TL teaches. The instructional objectives for each teach implicitly require this type of planning. Planning instruction by consciously attempting to satisfy the three variables in the learning situation cannot hamper your attainment of the instructional objectives for a teach. On the contrary, it should aid your achievement of them. In addition, you may find the model a useful guide for instructional planning in situations lacking the structure of TL teaches (e.g., student teaching, and, later, actual teaching).

Your first teach was important for other reasons than those previously expressed. It was, first of all, an unconscious statement of your previous definition of teaching, and of your concept of the role of a teacher. If your lesson is typical, your <u>implicit</u> definition of teaching might be something like "a human information-giver standing at the front of a group of students who occasionally writes on a blackboard, often refers to his notes, and always observes the unwritten rules of propriety and decorum." Assuredly, that is not the kind of teacher you want to be, nor is it an accurate picture of the teacher you are capable of being right now. It <u>is</u> a composite of the majority of teachers we have had, altered considerably by the situational variables of the Teaching Laboratory.

This manual is an attempt to give you more than just past experiences with teachers from which to build <u>your</u> concept of a teacher. When the Teaching Laboratory operates properly, it fulfills all three variables of the learning situation for a teacher candidate. If it did so on your first teach, you may now be experiencing some incongruity; start attempting to reconcile it.

PROBLEM-SOLVING

Your next five teaches will focus upon various aspects of the teaching of problem-solving. Problem-solving has been described and defined by many and, with few exceptions, one finds a surprisingly high amount of agreement between their formulations. In attempting a synthesis of their various views, Gagne(1966, p. 132) defines problem-solving as ". . . an inferred change in human capability that results in the acquisition of a generalizable rule which is novel to the individual, which cannot have been established by direct recall, and which can manifest itself in applicability to the solution of a class of problems."

Paraphrasing this definition so that its relationship to the learning model is made obvious results in an inferred change in an individual's capabilities that is the direct result of attempting to reconcile the incongruity present in a learning situation. This capability cannot have been a part of his developmental status prior to confrontation with the learning situation. The reconciliation of the incongruity is not adequately accomplished until the individual is able to apply his new capability to an entire class of similar problems. Ability to do this is self-perceived as a manifestation of the acquisition of new competence.

Historical Background. Problem-solving is no new concept. Plato and Aristotle both defined the act in much the same way as it is today. Dewey's philosophical writings and pedagogical practices gave renewed importance to the process by making it the focus of most if not all learning. Misinterpretations of Dewey's work led to many unfortunate excesses especially in the child-centered wing of progressive education. These acts subsequently tarnished the reputations of many schools successfully using his approaches or variations of them. Largely as a reaction to these excesses, a much more essentialistic philosophy stressing "efficient, rigorous" expository techniques came into the fore in the nineteen forties and early fifties and accelerated the already waning prominence of teaching for problem-solving.

Sputnik caused a complete reappraisal of the American educational system. This new and public examination resulted in a renewed emphasis on the teaching of process as a legitimate part of the content of courses (Bruner, 1960; Parker and Rubin, 1966). Numerous national curriculum projects began developing "new" ways of teaching specific subjects. If any one quality could possibly characterize all of them in their diversity it would be their attention to the teaching of process, including problem-solving (Goodlad, et al., 1966).

Philosophical Rationale. John Gardner, past secretary of the Department of Health, Education, and Welfare, once said "Too often we

give our children cut flowers when we ought to be teaching them to grow their own." The philosophy behind teaching for problem-solving centers around this position. Knowledge is never increased by simply learning that knowledge which already exists. Rather, it is increased by using it to generate new knowledge. Agreement is general on this point. Disagreement arises with respect to the means employed.

Some, including the essentialists, feel that knowledge will be generated naturally, that teaching the known culture is sufficient (Bestor, 1953, 1955; Lynd, 1953; Smith, 1949, 1956; Rickover, 1959, 1962, 1963). If a principle can be learned expositorally in one-tenth the time of discovering it, to learn it by the latter is ludicrous, and would, thereby, deprive the student of nine other principles that could be learned in the time necessary to "discover" one.

Others feel that this position is only part of the story, that students must not only learn how to know, but how to think or transform information (Piaget, 1968). To <u>become</u> a scientist, musician, or mathematician, one must <u>think</u> like a scientist, musician, or mathematician (Bruner, 1960; Combs, 1962). To do this effectively, one must teach students <u>how to think</u> in a particular discipline rather than leaving its development to chance. This manual adopts the latter position.

<u>Research on Problem-Solving</u>. Most problem-solving is taught inductively or by what is referred to as the "discovery" method. Examples

include those of Guthrie (1967), Laughlin and Doherty (1967), Klausmeier, et al. (1963), Worthen (1968), Ray (1961), Scandura (1966c), and Kersh (1958, 1962). In examining their results, few trends emerge, leading one to agree with Bellack (1956) who suggests that the advantages of a particular teaching technique cannot be easily generalized beyond the specific context of a study.

Bruner (1961) cites four advantages to discovery learning which represent an excellent synthesis of the conclusions drawn from the research. When used appropriately, the discovery method increases intellectual potency (the expectation of success or what this manual terms "competence"), intrinsic motivation, the learning of the heuristics of discovery (the strategies used in solving problems), and the amount of information actually retained. Perhaps the crucial factor here is appropriateness; various teaching techniques are usually best viewed as being appropriate or inappropriate to specific situations. When it is used appropriately, problem-solving can be a powerful teaching strategy. Problem-solving is not a panacea for all educational ills; it is one very important additional technique every teacher will find useful.

Problem-solving is generally seen as having four rather distinct phases. The first is the statement of the problem. Before one can begin solving a problem, one must have a very clear idea of

just what the problem is. What are its characteristics and limits? What are the relevant aspects of the total evironment?

The second phase is the formulation of the hypothesis. Once the nature of the problem is well defined, the natural consequent is to begin searching for a solution. At this point, one either formally or informally begins hypothesizing or guessing possible solutions for the problem.

Once hypotheses are suggested, verification of the hypotheses is then in order. Several of the hypotheses may be partial explanations of the principle necessary for solving the problem. One will most likely be or seem best. Verification of the correct guess may proceed in any fashion from blind trial and error to a rigorously controlled experimental situation (which is really only another kind of trial-and-error situation).

Once a tentative principle or solution rule is arrived at, a second type of verification, checking for transfer to new but similar situations is necessary. If the solution is in fact a valid identification of the crucial principle, it should be generalizable. Satisfaction of this phase of the problem-solving situation terminates the process allowing the individual to direct his attention to other activities.

Each of these four phases will be the focus for one of the following four teaches where the instructional tasks involved in

teaching each phase will be dealt with in more detail.

Teaching as a Role. Each person encounters several different social situations each day of his life, and he behaves differently in each. His behavior at a religious service differs greatly from that behavior at a party as it does when meeting a stranger as opposed to a close friend. On a more subtle level, your behavior as a student at the first meeting of a class probably differs from that of three weeks later. At the former, you are likely to be reluctant to say much and would rather get the feel of things first.

In this same sense teaching requires a different behavior. In fact, different kinds of teaching require different behaviors or roles. Applying the learning model to problem-solving results in a teaching role that changes with each phase of the problem-solving task. Appropriate roles for each phase will be discussed in more detail as they become pertinent.

LESSON TWO

CREATING INCONGRUITY: PRESENTING THE PROBLEM

In general, this task involves setting the stage. For problem-solving to be a useful instructional strategy, students and teachers must get started on the right foot. Specifically, this task involves at least five instructional tasks that are necessary for adequate satisfaction of the three variables of the learning model. They are: 1) finding an appropriate problem for students to solve; 2) analyzing the task with which the students will be confronted in solving the problem; 3) assessing the present developmental status (entering behavior) of the students; 4) teaching missing capabilities prerequisite to an ability to solve the problem; and 5) confronting the students with sufficient incongruity to stimulate problem-solving behavior.

Problem-finding. It is, first of all, necessary for you to find a problem of appropriate difficulty for the developmental status of your students. In effect, you are being asked to be creative. This is sometimes difficult so do not be reluctant to seek assistance. Such aid can range from getting the suggestions of a classmate to participation in a formal brainstorming situation.

The latter has been found to be quite effective in stimulating creativity (Parnes, 1961; Parnes and Meadow, 1959).

Brainstorming may be described briefly as a group of people firing ideas at each other for a period of time, say five to ten minutes, during which the emphasis is on quantity rather than quality; no idea is too silly or ridiculous. Persistence is important since the quantity and quality of ideas usually increases in the last half of the session.

Analyzing the Task. Once an appropriate problem has been found, it is advantageous to perform a rather thorough task analysis. Problem-solving generally is accomplished by the student acquiring the principle or generalization which explains an entire set of situations of which the problem solved is just one. Acquisition of the principle may be primarily a cognitive task as would most likely be true in mathematics and the sciences. It might be highly affective as in the arts, or it may be a psychomotor task as in physical education. It may combine fairly equal cognitive and affective components as might be true of the social studies, or components of all three as is the case of the task you are learning--teaching.

In general, task analysis involves starting with the principle to be acquired and working backward step by step until

one has a complete picture of the relevant learning processes involved in getting a student from where he is (entering behavior) to the instructional objective of acquisition of the principle (Gagne, 1962). Satisfying prerequisites is extremely important if the learner is to be capable of functioning independently at the desired higher learning level. Several taxonomies and hierarchical constructs can be of great assistance in performing a task analysis once you have determined the nature of its cognitive, affective, and psychomotor components.

For primarily cognitive tasks, Gagne's hierarchy (1965) is useful. He identifies seven different behaviors involved in "learning." The last four of these are applicable to normal school situations. The highest category is the use of strategies (e.g., problem-solving). In order to "solve," one must have command of all the generalizations essential to attacking the problem (i.e., the prerequisite category, use of principles). Before one can use principles, one must be able to classify information in those ways essential to the acquisition of a principle (i.e., the prerequisite category, use of class concepts). To form class concepts one needs to be able to perform appropriate acts in a specific order (i.e., the prerequisite category, behavior chains or sequences). Whenever

the principles, concepts, and behavior chains essential to the instructional objective (strategy) are apparent, this type of task analysis can be most informing. Topics in highly structured disciplines such as mathematics and the sciences most often fit this description.

The Bloom (1956) and Sanders (1966) taxonomies are helpful in a wide variety of learning situations. Their hierarchies are applicable to situations where students are asked to transform cognitive information with which they are presented. If the instructional objective requires that the students produce a plan of attack (synthesis) as might be the case in verifying hypotheses, they must first be able to determine the crucial qualities of the problem situation (analysis) to be successful at the synthesis level. To do this they must be able to <u>apply</u> information learned in other contexts. Application requires that they be able to comprehend (interpret) the relationships between previous situations and the present one. Lastly, one must have a <u>knowledge</u> of those facts that are prerequisite to transformations of information involving them.

The Krathwohl Taxonomy (1964) deals specifically with affective tasks be describing a hierarchy based on the degrees of involvement a student can experience in learning situations.

This Taxonomy identifies receiving (attending passively to incoming information) as its lowest level of involvement. Subsequent levels of the hierarchy are responding (actively attending), valuing (finding worth in the situation), organization (interpreting the relative importance of the values held), and characterization by a value or value complex (acting consistently with those values held).

No related Taxonomy exists for psychomotor tasks. In sufficient knowledge of this area makes such a formulation premature. A psychomotor task analysis is probably best performed by attempting to list the motor skills prerequisite to adequate fulfillment of the instructional objectives.

Piaget (1968) and Bruner (1964) both identify the importance of concrete referents as a prerequisite for abstract thought. Before one can use material symbolically (e.g., using language to describe reality), one must be able to use material iconically (e.g., using pictures or objects to describe reality). A prerequisite to iconic representations is an enactive representation (concrete experience with the actual object or act).

Regardless of the type of task analysis performed, identification of all the important prerequisite behaviors is essential. When a student lacks a prerequisite, he finds himself in the position

of having to resort to artificial means for solving a problem (e.g., rote learning, blind trial and error, etc.). Satisfaction of prerequisites allows him to function independently in the new situation.

Assessing Entering Behavior. Once the capabilities prerequisite to a successful encounter with the learning situation have been determined through the task analysis, the next task is to determine whether or not your students possess these capabilities. Capabilities may be cognitive in nature, such as a knowledge of the Bill of Rights, the ability to translate a story problem into an algebraic equation, or the ability to extrapolate present events into the future. They may be affective in nature, such as the harboring of an unconscious prejudice, or belief in specific values. Or they may be psychomotor in nature, such as the ability to touch specific keys on the typewriter without looking at them, the ability to dribble a basketball left-handed, or the ability to play an A-flat arpeggio at a specific tempo.

A lack of a prerequisite ability may be caused by at least three factors. One is obviously that the student just has not learned something to which he was previously exposed. Second, the ability may be missing because of his socio-cultural background. Millions of "disadvantaged" (and probably thousands of overlyadvantaged) students

have trouble in our middle-class oriented school system because we assume the presence of certain middle-class entering behaviors they do not possess. Third, a student may not have reached a stage of development necessary for the acquisition of certain abilities. While this problem is especially important at the elementary level, development does not stop there. For example, the attitudes arising from post-pubescent heterosexual relationships may be essential to certain topics you wish to teach.

Note that intelligence is not included in this list. Research indicates that teacher expectation is a powerful factor in the level of achievement reached by students (Rosenthal, 1968; Rosenthal and Jacobson, 1968). In most cases, the fairest, most realistic attitude to take is that students have the innate capacity to do the work and that any deficiency in capabilities is a result of the environmental factors discussed above and may be remedied if all the missing skills prerequisite to a task can be identified and enough time is available to teach them. Identification of missing prerequisites is important at this point because it is usually anticlimactic to stumble upon one in the "heat" of problem-solving activity and have to digress from it long enough to remedy the situation.

Teaching Missing Prerequisites. If missing prerequisites are identified, teaching them before the students are confronted with

the problem is most important. The studies of Scandura (1966a, 1966b, 1966c), Scandura and Behr (1966), Amster (1966), and Gagne (1962, 1964) all indicate that a student's premature entrance into a problem-solving situation results in his being generally ineffective in handling the problem in any productive manner. As a result, little learning takes place. If the problem selected is fairly appropriate to the capabilities of the students, teaching prerequisites should be a simple matter. If gross deficiencies are apparent, confrontation with the problem would best be postponed until a later more appropriate time.

Presenting the Problem. Once the previous four requirements have been met, the stage is set for the presentation of the problem (i.e., the confrontation with incongruity). An incongruity is curiosity-arousing. Berlyne (1954) and Festinger (1964) identify two factors determining the strength of the conflict causing the incongruity. The first is the degree of disagreement between two existing events. Take for example a situation in which a student believes strongly in some principle, be it the law of gravity, his own lack of prejudice, that Bach's music is unenjoyable to him, or any other well-established value or fact he holds to be true. Information in conflict with this belief, be it a strip of paper

defying gravity as an air stream is directed over it, a personal decision based on a prejudice, or a recording of the Swingle Singers, creates a curiosity-arousing incongruity. The amount of curiosity aroused is in part a product of the amount of conflict between these two events.

The second factor determining the degree of curiosity aroused is the relative strength of the two events. If one belief or the other can be easily rejected, little curiosity is aroused. If, however, both must be held tenaciously, great conflict can be created and with it activity aimed at reducing the incongruity. This is your final objective on this teach--to arouse sufficient curiosity to stimulate problem-solving behavior.

You are not required to go beyond this point for this task. Time requirements will probably prohibit actual entry into the problem-solving situation. If the assessment of entering behavior, the teaching of missing prerequisites, and the presentation of the problem takes less time than anticipated, you may elect to end your teach at that point or enter into problem-solving activity. The former is undoubtedly more appropriate if an adequate satisfaction of the incongruity cannot be accomplished in the time remaining.

INSTRUCTIONAL OBJECTIVES FOR THIS TEACH

1. The teacher candidate will teach a lesson segment eight minutes in length.
2. The teacher candidate will select a problem appropriate to the developmental status of his students. Appropriateness of the problem will be judged on the basis of its relevance to the students and how well the entering behavior of the students fulfills the prerequisites of the problem.
3. The teacher candidate will perform a thorough task analysis on the problem he has selected. Thoroughness will be judged as sufficient when it is apparent that his assessment of entering behavior indicates a knowledge of the behaviors prerequisite to the problem being presented.
4. The teacher candidate will identify the prerequisite behaviors that are not a part of the entering behavior of his students.
5. The teacher candidate will teach those prerequisite behaviors that are not a part of the entering behavior of his students. Adequacy will be judged by each of his students in terms of his conception of his ability to solve the problem after expending a reasonable amount of time and energy.

6. The teacher candidate will present the problem in a manner appropriate to the arousal of an optimum level of curiosity from his students. The criterion for evaluation will be each student's estimate of the curiosity the incongruity arouses in him.

EVALUATION GUIDE: LESSON TWO, PRESENTING THE PROBLEM

Teacher's Name_____

Your Name_____

Instructional Objectives for This Teach	Degree of Fulfillment: Optimum	Adequate	Minimal	Unfulfilled	Not Applic.
1. Time limit was observed within reasonable limits.	4	3	2	1	*
2. Problem was appropriate to students' developmental status.	4	3	2	1	*
3. Task analysis was sufficiently thorough.	4	3	2	1	*
4. Your missing prerequisite behaviors were identified.	4	3	2	1	*
5. Your missing prerequisite behaviors were taught (learned).	4	3	2	1	*
6. Presentation of the problem aroused your curiosity.	4	3	2	1	*

On the back of this form, identify the areas in which this teacher is strong and weak. Give your suggestions for improvement. In writing your comments, remember to a) be specific, b) be constructive, and c) write as extensively as you can.

Over-all Grade

4 3 2 1 0

A B C D F

LESSON TWO LISTENING GUIDE

NAME_____ SECTION_____

Complete and return this form to your instructor before you are to teach LESSON THREE.

This guide is designed to aid you in structuring your tape listening to better enable this feedback component of the TL to be of optimum benefit to you.

	Tallies	Total
1. Make a mark each time a student is able to answer a question you ask.		
2. Make a mark each time a student is unable to answer a question you ask.		
3. Make a mark each time a student asks you for further information.		
4. Make a mark each time you reinforce a student's contribution.		
5. Make a mark each time you do not reinforce a student's contribution.		
6. Make a mark each time you use some distracting mannerism (e.g., "uh," overuse of a specific word or phrase, etc.).		

In terms of the above information and that which you received on your comment sheets, what aspects of your teaching do you see a need to improve? How do you intend to attack these problems?

LESSON THREE

ATTACKING INCONGRUITY: FORMULATING HYPOTHESES

Once the requirements for Lesson Two have been satisfied, students are ready, hopefully eager to begin problem-solving activity. The task for Lesson Three is to accomplish the second phase of the problem-solving sequence, the formulation of hypotheses. The brainstorming technique is suggested as a productive strategy for accomplishing this phase. Brainstorming may be approached in one of two basic ways. A variation of one of these methods will most likely be appropriate for your particular topic.

Low Internal Evaluation Situation. For highly creative situations where there are no "right" answers, where your prime interest is in reducing convergent thinking and conventionality, an appropriate approach is to encourage students to suggest possible solutions as quickly as they occur to them. Quantity is emphasized with little or no regard given to quality. The rationale upon which this approach is based is that as more and more different ideas are suggested by the group, individuals are led to look at the problem from new frames of reference. These, in turn, produce more unique contributions. In a sense, the process becomes cyclical

in that old ideas continually generate new ones.

Research supports this rationale. Parnes (1961) and Parnes and Meadow (1959) found that this approach yielded a greater quantity of hypotheses, and that the hypotheses were, on the average, higher in quality than those obtained in a non-brainstorming situation. In addition, the quality of the hypotheses formulated was highest in the last half of the brainstorming session.

Three teaching strategies (or roles) are implied by these findings. When using this approach, a teacher must first reduce the amount of internal evaluation being made by students. Removing inhibitions might be another way of describing this strategy. Low internal evaluations can be accomplished in part through pre-brainstorming instructions that encourage this kind of behavior by directing students to postpone any evaluation of the efficacy of their various suggestions until a large pool of tentative hypotheses has been established.

Second, a teacher must be highly supportive and reinforcing to maintain the low-risk environment necessary for high student involvement. Bellack, et al (1966) describe instruction as a game in which the teacher sets the rules of play and has the right to change them at any time. Students quickly learn that the real rules of the game implied by a teacher's actions and reactions sometimes

contradict the rules he has set previously. Avoid rejecting answers as being silly or off-base if you have said previously that any idea is acceptable. In general, be sure that your actions are consistent with your instructions.

Since the quality of the hypotheses increases with time, it is also important to encourage persistence. Edison once remarked that the creative process involves a great deal more perspiration than inspiration. Research agrees with this view. The teacher's task is to keep ideas flowing by using the exhortations, prompts, and hints that are a part of guided discovery.

High Internal Evaluation Situation. For topics having a "right" answer, there may be advantage in having students attack a problem more directly. This goal can be accomplished in part by encouraging students to evaluate the efficacy of a hypothesis before offering it to the group. Guilford (1968) maintains that this sort of active evaluation is useful in situations where low-quality answers are detrimental to the problem-solving process. Your task is to identify the optimum level of internal evaluation for your topic. The optimum level is achieved when evaluation acts as a detriment to low quality answers but not to those of high quality. Once you have established what that level is, plan your instruction to foster it.

The three teaching strategies suggested for low internal evaluation situations are equally important here. Structuring the amount of internal evaluation desired is a necessary first step. Setting the ground rules for the search might be another way of describing the use of this strategy in a high internal evaluation situation.

Support and positive reinforcement are also important. A flat "no" response to a student's contribution is seldom necessary even in a situation having "right" answers. Questioning or probing a student further can usually bring him to see the fallacy in his contribution and he will then supply the "no." This approach is consistent with the desire to have students become more critical of their own contributions as well as those of others.

Encouraging persistence is also very important. With one exception, this strategy may be approached in much the same manner as it is in the low internal evaluation situation. When students are expected to be critical of their contributions it is necessary to allow time for thinking. When students are silent because they are apparently taking time to consider the situation carefully, exhortations to contribute are inappropriate. Any silence of more than a few seconds duration will undoubtedly make you feel

uneasy. You will probably feel a strong urge to say something just to fill the gap in the conversation. Remember though that silence has much the same effect upon your students. Because it does, the use of silence can be a powerful strategy for both allowing students time to think and as another method of eliciting responses from them. Exhortations, prompts, and hints are of course still in order whenever you judge your students' silence to be the result of a lack of ideas. Attempt to get the students to develop several alternative hypotheses. The availability of attractive alternatives will add interest to subsequent verification procedures.

The Teaching Task. If you did not take Lesson Two any further than the statement of the problem, Lesson Three can easily build upon it. You may wish to begin by spending a minute or two reviewing the prerequisite entering behaviors and restating the problem. If the topic of Lesson Two was completed, you will need to use these opening minutes for presenting your new problem. Because of time limitations, assume that entering behavior has been assessed and missing prerequisites have been taught. After you have set the ground rules for the search, have students suggest hypotheses. Use those teaching strategies appropriate for collecting hypotheses for your topic. Do not be overly concerned if the

"correct" hypothesis is not suggested. There will be ample opportunity to elicit it at the beginning of Lesson Four should the need arise. Once a reasonable number of hypotheses have been formulated, you have satisfied the requirements for this teach. If you would like to continue with this topic in Lesson Four, bring your lesson to a close short of attempting to verify the correct hypothesis. A quick review of the hypotheses suggested may provide a smooth close to your lesson. Should time permit and if you would prefer to use a new topic for your next lesson, you may begin the verification of hypotheses phase.

INSTRUCTIONAL OBJECTIVES FOR THIS TEACH

1. The teacher candidate will teach a lesson segment eight minutes in length.
2. The teacher candidate will concisely review the previous lesson and restate the problem in the first two or three minutes of the lesson.
3. The teacher candidate will adequately set the ground rules for the search for hypotheses. The instructions will be appropriate to the nature of the topic. Both criteria will be considered as achieved if the teacher candidate's subsequent actions are consistent with his instructions.

4. The teacher candidate will be supportive and positively reinforcing of students' contributions, and will avoid negative affect.
5. The teacher candidate will make appropriate use of silence in his lesson. Appropriateness will be considered satisfied when time is allowed for thinking whenever a need for this is the apparent cause of silence.
6. The teacher candidate will encourage students to be persistent through the use of appropriate means such as exhortations, prompts, and hints whenever necessary. A necessity will be defined as an extended duration of silence that is apparently not the result of students taking time to think.

EVALUATION GUIDE: LESSON THREE, FORMUATING HYPOTHESES

Teacher's Name _____

Your Name _____

Instructional Objectives for This Teach	Optimum	Adequate	Minimal	Unfulfilled	Not Applic.
1. Time limit was observed within reasonable limits.	4	3	2	1	*
2. A concise review of Lesson Two was given.	4	3	2	1	*
3. Teaching behavior was consistent with stated ground rules.	4	3	2	1	*
4. Positive reinforcement was appropriately utilized.	4	3	2	1	*
5. Strategy of silence was utilized whenever appropriate.	4	3	2	1	*
6. Persistence was encouraged whenever appropriate.	4	3	2	1	*

Degree of Fulfillment

On the back of this form, identify the areas in which this teacher is strong and weak. Give your suggestions for improvement. In writing your comments, remember to a) be specific, b) be constructive, and c) write as extensively as you can.

Over-all Grade				
4	3	2	1	0
A	B	C	D	F

LESSON THREE LISTENING GUIDE

NAME_____ SECTION_____

Complete and return this form to your instructor before you are to teach LESSON FOUR.

This guide is designed to aid you in structuring your tape listening to better enable this feedback component of the TL to be of optimum benefit to you.

	Tallies	Total
1. Make a mark for each student who actively participates in the lesson.		
2. Make a mark each time a student formulates a hypothesis (i.e., makes a guess or suggests a possible solution).		
3. Make a mark each time you reinforce a student's contribution.		
4. Make a mark each time you do not reinforce a student's contribution.		
5. Make a mark each time you use some distracting mannerism (e.g., "uh," overuse of a specific word or phrase, etc.).		

With an "X," estimate the percentage of total talking that was done by students.

Direct Teaching | 0 | 25 | 50 | 75 | 100 | Indirect Teaching

In terms of the above information and that which you received on your comment sheets, what aspects of your teaching do you see a need to improve? How do you intend to attack these problems?

LESSON FOUR

OVERCOMING INCONGRUITY: VERIFYING HYPOTHESES

At this point, your students are hopefully confronted with many possible explanations for the incongruity they have encountered. Your main task on this teach is to help them verify the correct or best hypothesis. In such a situation a useful teaching strategy may be to <u>not</u> teach. Staying out of the discussion as much as possible, allows students to make their own mistakes and find their own solution. One of your instructional objectives is to have your students make a formal statement of the principle that reconciles the incongruity.

The point during the lesson at which the correct or best hypothesis is verified, seems to make little difference. Dreas suggests that the climax come shortly before the end and you may wish to guide the verification process toward this outcome by having students work with some of the incorrect hypotheses first. There is, however, nothing wrong with verifying the correct hypothesis at the outset. If one alternative is clearly more feasible than the others, students may allow a delay in verification of it as a ploy attempt to avoid the obvious. In this case, early verification of the correct hypothesis is advisable. One can then examine the other hypotheses to determine why they are unacceptable or less appropriate.

Verification procedures are usually best dictated by the nature of the discipline involved as well as the topic. One reason for teaching problem-solving is to get students thinking like scientists, mathematicians, linguists, artists, historians, etc. Encourage students to use the methodology of your discipline. Too little attention to process has been a past characteristic of the teaching of most disciplines even at the undergraduate level. You may therefore be uncertain of what your discipline's methodology encompasses. Your TA instructor and major professors can be of assistance in this case.

The Teaching Task. If you did not take Lesson Three any further than the formulation of hypotheses, Lesson Four can easily build upon it. You may find it best to spend a minute or two reviewing the hypotheses suggested during the last lesson and asking if the students have thought of any additional ones. If Lesson Three included some verification it may be possible to start at that point with this lesson. If a new topic is desirable, spend these first minutes presenting the new problem and suggesting some possible hypotheses to the students. Verification procedures may then be started. When sufficient verification has been accomplished, have students compose a formal statement of the principle involved.

Accomplishment of these tasks satisfies the requirements for this lesson. Bring your lesson to a close. You may again opt to continue, if time permits, by beginning to check for transfer of the principle to new situations.

INSTRUCTIONAL OBJECTIVES FOR THIS TEACH

1. The teacher candidate will teach a lesson segment eight minutes in length.
2. The teacher candidate will review the hypotheses formulated in Lesson Three.
3. The teacher candidate will encourage use of the investigative methodology of the discipline he is teaching. The time available is acknowledged to be a serious limitation to the achievement of this objective and will be considered in judging its attainment.
4. The teacher candidate will guide the students' verification procedures in an indirect manner, allowing students to largely control the procedure.
5. The teacher candidate will direct the students to compose a formal statement of the principle reconciling the incongruity.

EVALUATION GUIDE: LESSON FOUR, VERIFYING HYPOTHESES

Teacher's Name_____

Your Name_____

Instructional Objectives for This Teach	Degree of Fulfillment: Optimum	Adequate	Minimal	Unfulfilled	Not Applic.
1. Time limit was observed within reasonable limits.	4	3	2	1	*
2. Hypotheses formulated in Lesson Three were reviewed.	4	3	2	1	*
3. Use of discipline's investigative methodology was encour.	4	3	2	1	*
4. Students largely controlled the verification procedure.	4	3	2	1	*
5. Students composed a formal statement of the principle.	4	3	2	1	*

On the back of this form, identify the areas in which this teacher is strong and weak. Give your suggestions for improvement. In writing your comments, remember to a) be specific, b) be constructive, and c) write as extensively as you can.

Over-all Grade				
4	3	2	1	0
A	B	C	D	F

LESSON FOUR LISTENING GUIDE

NAME_____ SECTION_____

Complete and return this form to your instructor before you are to teach LESSON FIVE.

This guide is designed to aid you in structuring your tape listening to better enable this feedback component of the TL to be of optimum benefit to you.

	Tallies	Total
1. Make a mark for each hypothesis for which some verification is attempted.		
2. Make a mark each time a student suggests a procedure for verifying a hypothesis or in some manner indicates that he feels he has at least partial control over the direction of the lesson.		
3. Make a mark each time it is evident that your students are thinking as a person in your discipline would (i.e., using the investigative methodology of your discipline).		
4. Make a mark each time it is necessary for you to give direction or redirection to your students' verification process.		
5. Make a mark each time your students ask you for further information.		

With an "X," estimate the percentage of total talking that was done by students.

Direct Teaching | 0 | 25 | 50 | 75 | 100 | Indirect Teaching

In terms of the above information and that which you received on your comment sheets, what aspects of your teaching do you see a need to improve? How do you intend to attack these problems?

LESSON FIVE

ELIMINATING THE INCONGRUITY: APPLYING THE GENERALIZATION

Your task on this teach is to use two basic strategies. The first involves assessing how much your students have learned. Traditional testing procedures are only one (often quite inappropriate) method of accomplishing this. The second strategy involves helping students to better grasp the problem-solving processes they have used by having them verbally introspect them.

The final phase of the problem-solving sequence may be viewed as being another type of verification procedure. Often an individual is not completely confident that he has mastered a learning situation until he has proven to himself that he can apply the principle in new situations. In situations where a learner does not feel he needs this mastery, checking for transfer is nevertheless a crucial instructional strategy for the assessment of learning.

But the learning of the principle is only one of the two major objectives teaching through problem-solving seeks to attain. The second is, of course, the acquisition of the process abilities (i.e., the heuristics or investigative techniques) of a discipline.

The first step in this acquisition was to have students, perhaps unconsciously, use your discipline's investigative methodology. A second step is required if students are to have gained any meaningful command of your discipline. You must make certain that they are consciously aware of the processes they have used as one way of better insuring their ability (power) to use these tools again (Berman, 1968). Verbal introspection of the problem-solving process is an effective means for accomplishing this awareness.

Checking for Transfer. In solving their problem, your students have probably been concerned with one isolated instance in which the principle they are acquiring holds. However, the true test of their command of the principle is their ability to generalize it to new situations in which it also operates. In other words, checking for transfer is an important step in the problem-solving process.

Several avenues are available for accomplishing this. Perhaps the most obvious is to present the students with new situations and have them explain how or why the principle applies. A second is to present the students with a situation where the principle appears to apply but in fact does not. The explanation of how or why is a good deal more demanding here and may only be useful in cases where students understand the principle that does explain the situation. A

third method is to have the students identify the new situations in which the principle operates. Again, explanations of how and why are helpful in assuring that all students understand the generalization.

Introspecting the Processes Used. One may conceptualize this teaching strategy as another means of insuring transfer. The difference is that the interest, in this case, is in the transference of processes. A problem-solving approach is ludicrous if students only acquire the principle they seek. As mentioned earlier, simply telling them the principle is a great deal more efficient. The value of the problem-solving approach lies in its ability to teach process, to give students the tools necessary to extend knowledge beyond its present limits.

In much the same sense that a carpenter cannot use a tool he does not own, your students cannot use a process unless they are aware of it. Admittedly, awareness of a process does not assure an ability to use it anymore than ownership of a chest of tools makes one a carpenter. It is, however, an essential first step.

Awareness can be accomplished simply by having students talk through the procedures they have followed in arriving at a formal identification of the principle that answers the questions that aroused their curiosity. Your ability to use effective questioning strategies will aid this recapitulation considerably. Why did the students formulate

the hypotheses they did rather than others? How did they formulate them? Why did they choose to evaluate that hypothesis first? How did they verify the hypotheses? Why that method rather than this? These are only some general examples of questions that may lead students to verbalize the crucial procedures they have unconsciously used. In terms of the learning model, you are taking this opportunity to show students how sophisticated their thinking really is as a way of building competence.

The Teaching Task. You may find a restatement of the principle and some minor review of Lesson Four as an effective opening for this lesson. An assessment of learning through checking for transfer seems a logical next step. Use whatever means you deem most appropriate for accomplishing this. Remember that a formal test situation will likely stifle whatever realism you have succeeded in instilling in the learning situation.

Once you are satisfied that students have command of the principle, introspection is in order. Decide what the most pertinent procedures used by the students were, and plan your questioning to elicit them. Praise is important, but students should also be led to an awareness of their inappropriate procedures so that they may avoid using them in subsequent similar situations. Remember also that a major goal in this phase of the problem-solving sequence is to increase your

student's concepts of their own competences. Assume the kind of supportive role that will facilitate the attainment of this objective.

INSTRUCTIONAL OBJECTIVES FOR THIS TEACH

1. The teacher candidate will teach a lesson segment eight minutes in length.
2. The teacher candidate will make a concise review of the previous lesson.
3. The teacher candidate will assess learning by checking his students' ability to transfer the principle to new situations.
4. The teacher candidate will check for transfer by using means appropriate to his topic and discipline.
5. The teac her candidate will lead his students to verbally introspect the problem-solving act. This objective will be deemed satisfied when the students feel they are aware of the procedures they have used.
6. The teacher candidate will foster competence by assuming a supportive role. This objective will be deemed satisfied if the students feel more capable of dealing with problems in that discipline as a result of their problem-solving experience.

EVALUATION GUIDE: LESSON FIVE, CHECKING FOR TRANSFER

Teacher's Name_____

Your Name_____

Instructional Objectives for This Teach	Degree of Fulfillment				
	Optimum	Adequate	Minimal	Unfulfilled	Not Applic.
1. Time limit was observed within reasonable limits.	4	3	2	1	*
2. A concise review of previous lesson was made.	4	3	2	1	*
3. Learning was assessed by checking for transfer.	4	3	2	1	*
4. Transfer was checked by means appropriate to the topic.	4	3	2	1	*
5. Students introspected the problem-solving process.	4	3	2	1	*
6. The lesson increased <u>your</u> conception of your competence.	4	3	2	1	*

On the back of this form, identify the areas in which this teacher is strong and weak. Give your suggestions for improvement. In writing your comments, remember to a) be specific, b) be constructive, and c) write as extensively as you can.

Over-all Grade				
4	3	2	1	0
A	B	C	D	F

LESSON FIVE LISTENING GUIDE

NAME_____ SECTION_____

Complete and return this form to your instructor before you are to teach LESSON SIX.

This guide is designed to aid you in structuring your tape listening to better enable this feedback component of the TL to be of optimum benefit to you.

	Tallies	Total
1. Make a mark each time a student displays an ability to transfer the principle to a new situation.		
2. Make a mark each time you encourage students to transfer the principle.		
3. Make a mark each time you reinforce a student's contribution.		
4. How well were students able to verbalize (introspect) the learning process they had experienced?		

This has been a first attempt at teaching problem-solving and your success to this point should therefore be viewed in relation to your abilities before this first attempt.

In effect, you too have been involved in problem-solving behavior in attempting to teach these tasks and it may now be of some value for you to introspect the processes you have used. How many of them were intuitive? How can you make intuitive processes more purposive? Enumerate your successes, however modest you may feel they are. More importantly, identify those areas in which you feel you must improve and prescribe the means you see as necessary to achieve that improvement. Use the back of this sheet if additional space is necessary.

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